TABLE NO. 3.—*Duration of precipitation (hours) during the crop growing season at Havre, Mont., April 1, to September 30, trace hours omitted (automatic registration)*

Month	A. M.												P. M.												Total
	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	9	10	11	Mid-night	
April	1.8	2.2	2.1	2.1	1.7	1.4	1.4	1.6	1.4	1.4	1.2	1.6	1.2	1.2	1.2	1.4	1.0	1.2	1.4	1.9	1.7	2.2	2.2	2.5	39.03
May	2.1	2.1	1.6	1.7	1.4	1.8	1.0	1.4	1.3	1.7	1.4	1.4	1.2	1.2	1.1	1.4	2.1	2.1	1.6	2.5	1.9	2.3	2.2	2.1	40.74
June	2.2	2.3	2.2	2.4	2.1	1.9	2.0	1.8	2.0	1.4	1.3	1.4	1.5	2.0	1.5	1.6	1.8	1.9	1.6	1.9	2.3	2.5	2.8	2.4	46.85
July	1.7	1.4	1.4	1.2	0.7	0.7	0.8	1.0	0.9	0.7	0.7	0.8	0.6	0.7	0.6	0.9	0.6	0.6	0.5	1.2	1.2	1.1	1.3	1.8	23.05
August	0.8	1.0	1.0	0.9	0.8	0.9	0.8	0.8	1.0	0.8	0.8	0.8	0.5	0.6	0.2	0.4	0.6	0.7	0.6	0.9	0.8	1.1	1.0	0.7	18.78
September	1.9	1.7	1.8	1.7	1.8	1.9	1.5	1.6	2.2	1.5	1.3	1.2	1.5	1.1	1.1	1.2	1.2	1.0	1.0	1.5	1.6	1.6	1.9	2.2	37.09
Sum	10.5	10.7	10.1	10.0	8.5	8.6	7.5	8.2	8.8	7.5	6.9	7.2	6.5	6.8	5.7	6.9	7.3	7.5	6.7	9.9	9.5	10.8	11.4	11.7	------
Mean	1.8	1.8	1.7	1.7	1.4	1.4	1.2	1.2	1.5	1.2	1.2	1.2	1.1	1.1	1.0	1.2	1.2	1.2	1.1	1.6	1.6	1.8	1.9	2.0	------

TABLE NO. 4.—*Duration of precipitation (hours) during the winter season, at Havre, Mont., October 1 to March 31, trace hours omitted (hourly amounts estimated)*

Month	A. M.												P. M.												Total
	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	9	10	11	Mid-night	
October	0.5	0.7	0.6	0.9	0.7	1.0	1.1	0.7	0.7	0.8	0.8	0.7	0.5	0.8	0.6	0.7	0.6	0.7	0.7	0.8	0.6	0.7	0.9	0.4	17.06
November	0.6	0.7	1.5	1.7	2.0	1.1	1.3	1.5	1.5	1.3	1.4	1.9	1.6	2.0	1.8	1.5	1.6	1.3	1.4	1.1	1.4	1.4	0.8	0.9	33.14
December	1.3	1.3	1.4	1.4	1.7	1.4	1.7	1.6	1.3	1.1	1.0	1.6	1.6	1.1	1.6	1.4	1.6	1.3	1.0	2.0	1.8	1.6	1.6	1.3	34.66
January	1.7	1.6	1.5	1.1	0.7	0.7	0.7	0.5	0.9	1.0	1.4	1.3	1.2	0.8	1.4	0.8	1.3	1.0	1.1	1.2	1.6	1.9	1.5	2.0	28.73
February	0.8	1.1	1.1	1.5	1.4	1.2	1.1	1.0	1.2	0.8	1.3	1.2	1.2	0.8	0.9	1.2	1.4	1.5	1.8	1.9	1.8	1.7	1.7	1.2	30.79
March	1.7	1.8	1.6	1.6	2.1	1.5	1.1	1.1	1.0	1.3	1.2	1.1	0.9	1.7	1.2	1.0	1.4	1.3	1.4	2.1	1.7	1.9	2.0	1.9	35.64
Sum	6.6	7.2	7.7	8.2	8.6	6.9	7.0	6.4	6.6	6.3	7.1	7.8	7.0	7.2	7.5	6.6	7.9	7.1	7.4	9.1	8.9	9.2	8.5	7.7	------
Mean	1.1	1.2	1.3	1.4	1.4	1.2	1.2	1.1	1.1	1.0	1.2	1.3	1.2	1.2	1.2	1.1	1.3	1.2	1.2	1.5	1.5	1.5	1.4	1.3	------

551.576

UTILIZATION OF FIXED SEARCHLIGHTS IN MEASURING CLOUD HEIGHTS

By IRVING F. HAND

[Weather Bureau, Washington, November 6, 1929]

For the past few weeks the writer has been making cloud-height determinations by means of the angular measurement of the location of a spot of light cast upon clouds by a powerful searchlight. The merit of the method, if there be any, lies in the simplicity, rapidity, and accuracy of the measurements, as the cloud height at any given time may be determined in less than a minute.

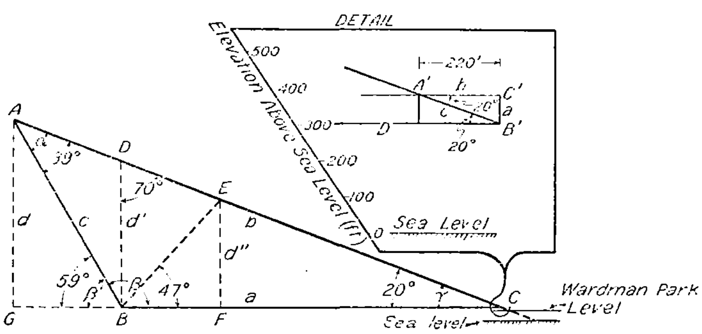

FIGURE 1.—Triangle formed by base line, BC, light beam, CA, and line of sight, BA

The searchlight utilized for this purpose is at an elevation of 300 feet on top of the Wardman Park Hotel, District of Columbia, and swings in a circle 20° from the horizontal once every 25 seconds. The method consists in measuring the altitude of the spot of light when it is in a vertical plane including the point of observation and the source of light. Simple triangulation then shows the height of the spot of light, or the cloud height, above ground, sea level, or any other base desired.

The point of observation in the example here cited has been the writer's home in Wesley Heights, D. C., having an elevation of 380 feet and being distant 10,520 feet from a point 80 feet directly over the searchlight. By computing the distance A' C', shown in the insert of Figure 1, by use of the formula $b = a \cot A'$ where $a = (380–300)$ and $A' = 20°$ (fixed elevation of light), we obtain the value of 220 feet, which, subtracted from 10,520 feet, leaves 10,300 as the value of BFC in the main drawing of Figure 1, where C represents the point of intersection of the beam of light with the horizontal plane of observation, and B, the point of observation.

To solve for d, we have

$$c = \frac{a}{\sin \alpha} \sin \gamma \text{ and } d = c \sin\beta' = \frac{a \sin \gamma \sin \beta'}{\sin \alpha}.$$

Instead of using the angle α, we may use compliments of angles by substituting $\sin \beta$ for $\sin \beta'$ in the numerator and $\sin (20° + \beta)$ for $\sin \alpha$ in the denominator, whereby we use measured angles for computation. Thus the formula becomes

$$d = \frac{a \sin \gamma \sin \beta}{\sin (20° + \beta)} \tag{1}$$

Examples: When $\beta = 121°$, 90°, and 47°, respectively; or greater than, equal to, and less than a right angle.

$\beta = 121°$

log 10300 (a)	=4.01284	
log sin 20° (γ)	=9.53405	
log sin 121° (β)	=9.93307	
colog sin (20°+121)	= .20113	
Antilog	=3.68109	d=4798

$\beta = 90°$

log 10300 (a)	=4.01284	
log sin 20° (γ)	=9.53405	
log sin 90° (β)	=0.00000	
colog sin (20°+90)	= .02701	
Antilog	=3.57390	d'=3749

$\beta=47°$

log 10300 (a)	$=4.01284$
log sin 20° (γ)	$=9.53405$
log sin 47° (β)	$=9.86413$
colog sin (20°+47°)	$=.03597$
Antilog	$=3.44699$ $d''=2799$

Cloud heights with all altitudes of the spot of light between and including 0° and 150° are shown by Figure 2.

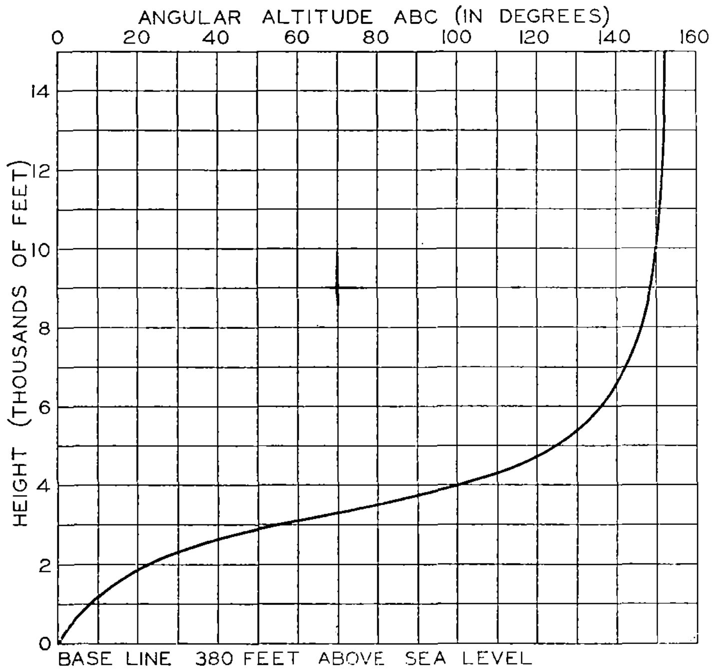

FIGURE 2.—Cloud heights corresponding to various angles of sight, β

It is interesting to note, but perfectly obvious why, that the relation between cloud heights and the distance BC is linear; that is, if the distance BC were 1,030 feet instead of 10,300 feet, all cloud heights shown in Figure 2 would be diminished to one-tenth of their indicated values. Thus, if observations are chiefly desired of cloud heights between 0 and 500 feet, as is usually the case at flying fields, it would be better to have a lesser distance between the light source and the point of observation than that given in the example herewith, but for cloud observations where no additional weight is to be given any particular height, as in the case of regular Weather Bureau cloud observations, it would be preferable to have the observing station so located that a value of 70° for ABC would indicate mean cloud heights. Inspection of Figure 2 shows why this is true, for it will be seen that this is roughly the most nearly horizontal portion of the curve. The heights on curve A rapidly approach infinity when the angle ABC begins to exceed 155°.

Table 1 gives cloud heights corresponding to distances BC of 10,300 feet, 1,000 feet, and 500 feet, respectively, for values of the angle ABC from 1° to 157°, inclusive. These values, however, represent heights above the 380-foot plane and must be added to this latter figure to obtain heights above sea level.

TABLE 1.—*Height of clouds above 380-foot plane corresponding to values of the angular altitude of the spot of light*

Angular altitude, ABC	Value of BFC in feet			Angular altitude, ABC	Value of BFC in feet		
	Height, 10,300 feet	Height, 1,000 feet	Height, 500 feet		Height, 10,300 feet	Height, 1,000 feet	Height, 500 feet
°				°			
0	0	0	0	70	3,310	321	161
1	172	17	8	80	3,523	342	171
2	328	32	16	90	3,749	364	182
5	726	70	35	100	4,006	389	195
10	1,223	119	59	110	4,322	420	210
20	1,875	182	91	120	4,746	461	230
30	2,299	223	112	130	5,397	524	262
40	2,621	254	127	140	6,621	643	321
47	2,799	272	136	150	10,380	1,007	504
50	2,872	279	139	155	17,082	1,658	829
60	3,098	301	154	157	94,985	9,222	4,618

It matters little whether the station is above, below, or on the level with the searchlight. In the first case, the base line is shortened, in the second case it is lengthened, and in the final case no adjustment for height is necessary.

All observations have been made with the alidade of a polariscope, but an altitude finder may readily be fabricated by the use of a brass tube equipped with cross hairs, a protractor, indicating pointer, and standard, at a nominal cost.

A table similar to Table 1, but more comprehensive, should be prepared for use at all stations where regular observations are made as it would soon more than save the amount of time it takes to prepare it.

NOTES, ABSTRACTS, AND REVIEWS

Harry Crawford Frankenfield—an appreciation,[1] *by Dr. Jules Schokalsky, Leningrad, U. S. S. R.*—A post card from my friend Gen. A. W. Greely advised me that an accident had brought to a close the life of Harry Crawford Frankenfield, a man universally loved and esteemed by his many friends. I beg to be permitted to express my personal sorrow in his untimely end and to join with his colleagues of the opposite part of the hemisphere in paying tribute to his memory.

In 1912 while a member of the American Geographical Society's transcontinental excursion, I had the pleasure and opportunity of meeting Frankenfield and discussing with him the many physical problems in which we had a common interest and there was then formed a friendship that endured until the end.

His letters which continued until his death afforded me not only the joy of a kindly scientific support but also revealed in him that quality of spirit possessed only by great souls.

The life and work of Frankenfield, revealing as they did his fine character and sympathetic attitude toward his scientific colleagues assured to his memory their lasting esteem although widely separated in space and time.

Leningrad; November 22, 1929.

MAURY [1]

Two biographies, Life and Letters of Matthew Fontaine Maury, by J. A. Caskie (Richmond, Va.) (press, 1928, 191 p., $3), and Matthew Fontaine Maury: The Pathfinder of the Seas, by C. L. Lewis (the United States Naval Institute, Annapolis, 1928, $6)[2] have recently brought clearly to light the amazing accomplishments

[1] *Cf.* Henry, A. J. Harry Crawford Frankenfield, 1862–1929, Mo. WEA. REV. 57: 254.

[1] *Cf.* Roscoe Nunn's biographical note in the Bulletin, January, 1928, p. 7.
[2] *Cf.* Reviews in *The New York Times*, Mar. 18 and June 17, 1928, respectively.